Program of Waste Disposal Control at Sinegorskaya Mine

Project Title: Model Program of Waste Disposal Control at Sinegorskaya Mine
Project Leader: Shakhta Sinegorskaya, Sakhalin Region, Russia
Project Partner: EarthFax Engineering, Inc., Midvale, Utah
Location of Project: Sinegorsk, Sakhalin Island, Russia Far East
Project Duration: September 2000 - June 2001
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Best Practice: Transferable Solutions

This project "Improving Waste Management at Sinegorskaya Mine" is an EcoLinks Best Practice. The project developed low tech, low cost measures to improve waste disposal and management at underground coal mines, minimizing the environmental impacts of mining. At the same time, the project assessed the potential to reuse the coal in rock waste piles, which will reduce the size and impact of the piles, while bringing additional revenue to the mine. The recommendations and Model Plan developed through this EcoLinks funded project are highly transferable to other underground coal mines in the NIS (with the exception of recommendations concerning the Sinegorsk town boiler).

Project Summary

Underground coal mining has been conducted at the Sinegorskaya Mine since 1913. Beginning in 1945, waste rock generated from the mine has been deposited into waste rock piles at the site, the total volume of which is currently estimated at 4,000,000 m^3. Because coal processing at the Sinegorskaya Mine is not highly efficient, these waste piles contain not only waste rock (shale and sandstone) but also a significant amount of coal.

This waste, now piled into four dumps at the edge of the town of Sinegorsk, presents a serious environmental hazard. In its current form, the waste piles have destroyed 19 hectares of landscape. Heavy metals from the piles leach into the groundwater and sediment from the piles runs off to adjacent areas, including into the Susuya River. Fine particle dust blows from the piles into the atmosphere and particulate matter content in the air near the mine exceeds permissible limits approximately 50% of the time. Finally, because of the high coal content in the waste piles and the way the waste piles have been formed, the piles are subject to spontaneous combustion, with regular, frequent burns occurring in the summer months.

The goal of this project was to develop a Model Program to improve waste disposal and treatment at the Sinegorskaya Mine. The Project Team assessed the potential for initiating low and no cost measures at the mine to minimize the environmental impacts of coal mining and processing. Recommendations focused on four areas: (1) reducing and capturing the sediment/leaching from the piles; (2) recovering the coal in the waste piles; (3) improving waste disposal/treatment; and (4) improving efficiency of the coal-fired district heating boiler in the town of Sinegorsk. Results of the Project Team's analysis show that the coal in waste piles can be recovered with little processing, and that this coal represents a potential $450,000 in additional annual revenue to the mine.

Project Activities

The main goal of this project was to develop recommendations to improve waste disposal and treatment at the Sinegorskaya Mine. Project activities included the following:

1. Assessment of Conditions at the Mine

Action: The Project Team surveyed, reviewed, and assessed current conditions at the mine, including current coal processing methods and geological conditions at the mine. The formation of the coal seams in the mine create very difficult mining conditions and result in the generation of a large amount of waste rock during the mining process. Coal is mined using longwall methods and brought to the service by underground rail cars. Waste rock is separated out by inefficient hand procedures after the coal is brought to the surface. This is accomplished as the mined material passes along a conveyor, and workers visually evaluate the material. If the material is judged to contain more than 45% coal, it is diverted to the coal pile. If the material is judged to contain less than 45% coal, it is diverted to the rock waste pile.

Approximately 100,000 tons of coal is produced from the mine annually. The coal is of high quality, with the following typical properties:

Ash	Moisture	Sulfur	Heat Content
17%	8.3%	0.28%	6,600 kcal/kg

Due to the dip of coal seams at the mine, the Project Team determined that there were no realistic options for improving efficiency of the mining process itself, and therefore focused their recommendations on treatment and storage of waste in the following project activities.

Product(s): 1) Analysis of pre-project mining processes and conditions at Sinegorskaya Mine.

2. Analysis of Waste Rock

Action: Waste rock from the dumps of each of the four piles was collected for laboratory analyses carried out in the United States. Laboratory analysis showed that the Sinegorsk waste rock contains approximately 50% coal. Furthermore, the coal in the waste rock piles proved to be of high quality.

Properties of waste rock from Sinegorskaya

Ash	Moisture	Sulfur	Heat Content (corrected for moisture and ash)
54.5%	13.7%	0.15%	6,590 kcal/kg

Product(s): 1) Analysis of content of waste rock piles at Sinegorskaya Mine.

3. Environmental Assessment of Waste Piles

Action: The four waste rock piles have been created over the past 50+ years. Piles 1,2 & 3, the older piles, are similar in formation and content. Pile 4, the pile into which waste rock is currently deposited, differs from the other piles in that it is flattened regularly with a bulldozer, which keeps the surface of the pile flat, thereby allowing water to accumulate on the pile and decreasing slope stability. Although Piles 1, 2 & 3 have naturally revegetated, the active working of Pile 4 precludes the establishment of a good vegetative cover.

An environmental impact assessment of the waste rock including assessment runoff impacts, slope instability risk, partical dust impacts, and spontaneous combustion was conducted. A topographic map of the waste dumps was developed. Legislative norms and regulations concerning disposal of mine waste and utilization were reviewed.

Product(s): 1) Environmental impact assessment of the waste piles.

4. Site Visit to Coal Mines and Processing Facilities in the USA

Action: Sinegorskaya Mine's head engineer traveled to the USA to learn about structures, designs, processes and equipment used at mines in the United States to minimize the environmental impact of mining and coal processing. The Sinegorskaya Mine representative was given an underground tour of the SUFCO Mine in Salina, Utah, and a surface tour of the Star Point Mine, Willow Creek Mine, and Hardscrabble Canyon Mine. The Project Team toured the underground operations of the SUFCO Mine, where longwall mining techniques are used to create one of the most productive underground coal mines in the USA. At the Star Point Mine, the Sinegorskaya Mine representative was shown run-off and sediment control facilities similar to those recommended by the Project Team. At the Willow Creek Mine, mine management gave a presentation on their coal preparation and washing facility, which is used to separate coal from waste rock; sediment control and run off facilities were also visited. The Sinegorskaya Mine representative also visited the Sunnyside Cogeneration Power Plant, which uses coal waste rock as fuel, without significant processing, in a circulating fluidized bed combustor (such a combustor may be appropriate for the town boiler in Sinegorsk). At Hardscrabble, The Sinegorskaya Mine representative was given a presentation on land that has been reclaimed at the mine site after 120 years of mining. The US study tour was arranged by the US project Partner, EarthFax Engineering, Inc.

Product(s): 1) Improved understanding of waste management methods used in coal mines in the USA.

5. Site Visit to Sakhalin

Action: The US Partner traveled to Sakhalin and Sinegorsk to visit mine and governmental officials and to work with the Project Leader in finalizing the recommendations for the ModelProgram. While in Yuzhno Sakhalinsk, the US Partner representative met with the Vice Governor of the Sakhalin Region, with the Chairman of the Committee on Economics and Industrial Policy, with the Vice Mayor, with the Chairman of the Department of the Committee on Natural Resources, with the Director of the Department of Fuel, Energy and Mineral Resources and with the Head of the Department of Mining Inspection to discuss project findings. Through these meetings, potential sources of follow up funding for implementation of project recommendations were identified in the Governor's Office and in the City Administration of Yuzhno-Salhalinsk. Officials from the Department of Mining Inspection and the Department of Fuel, Energy and Mineral Resources and the Department of Natural Resources provided their endorsement for applying this program at other appropriate mines on Sakhalin Island. The Project Leader arranged the US Partner's visit and meetings.

Product(s): 1) Information on project results disseminated to Sakhalin Island government officials. 2) Potential sources of follow-up finding identified.

6. Development of Project Recommendations and Model Program

Action: The Project Team developed a Model Program for waste processing and disposal at the mine. The main recommendations included in this Program are:

- **Sedimentation Control**
  Two methods of run-off and sedimentation discharge control are presented in the Model Program. The first involves constructing a run-off basin at the downstream end of the pile access road. An abandoned wastewater pond constructed with concrete walls exists at a nearby, down slope location. This wastewater pond can be modified using existing mine equipment to make a sediment basin to capture runoff from the piles. Once the sediment has settled to the bottom of the pond, the treated water can be released to the Susuya River. Second, the Model Program recommends that loose-rock check dams be installed at intermittent locations within the ditches that run along the waste-rock pile access roads. Run-off water will collect behind these dams, allowing the sediment to settle out. These dams will help to limit the amount of sediment discharge that currently runs freely through the down-slope ditches into the Susuya River. Sediment from both the sediment basin and the loose rock check dams will have to be removed to one of the waste piles periodically.

  Since the materials, equipment and manpower required to implement these recommendations are available at the mine, the recommendations can be implemented at no capital cost to the mine.

- **Waste Coal Recovery**
  The Model Program developed by the Project Team recommends that coal be recovered from the waste piles by cyclone separation. This process involves first screening and then crushing the waste rock. Water is then added to the crushed waste rock, and this slurry is

pumped through a cyclone separation system, which will separate the slurry into fine and coarse refuse and clean coal. At this point, the coal may be used without any further processing.

New screens, a crusher, cyclones, and pumps will have to be purchased and installed to implement the coal recovery recommendations. It is estimated that the cost of coal recovery will be approximately $11.15 per metric ton. The cost of mining new coal from Sinegorskaya Mine is between $22-$25 per metric ton. Thus, coal can be recovered from the waste piles at about half the cost of mining new coal.

- **Improved Treatment of Waste Piles**
  Pre-project waste rock disposal at the mine encouraged slope failure, spontaneous combustion, infiltration of precipitation which in turn leaches contaminants into nearby surface and ground water, and high wind blown particulate matter. In order to minimize these risks and environmental impacts, the Model Program recommends several measures, including: (1) removing vegetation and topsoil from areas where waste rock will be disposed of; (2) separation of organic waste (used mine timbers) from the rock pile prior to disposal; (3) compacting the dumped waste rock to promote stability; and (4) ceasing disposal of town garbage in the waste rock piles. All of these measures are designed to limit the amount of oxygen in the piles (which can lead to spontaneous combustion) and the amount of precipitation that seeps into the piles (which reduces pile stability and leads to leaching into the ground and surface water).

  The equipment and manpower to implement these recommendations already exists at Sinegorskaya mine. Thus, no additional capital costs will be required to implement these measures.

- **Boiler Conversion/Replacement**
  The Sinegorsk town district heat boiler runs on coal mined from the Sinegorskaya Mine. The boiler was built in 1913 and has had only several upgrades and modifications since. The boiler is extremely inefficient, and removes only about 28% of the heat value from the coal. Although the boiler is not the property of Sinegorskaya Mine, and an assessment of the boiler was not originally planned in this project, coal waste from the boiler is disposed of in Sinegorskaya's waste rock piles. Since the boiler's inefficiency contributes to Sinegorskaya Mine's waste disposal problems, the Project Team decided to do a preliminary assessment of the town boiler. This initial assessment showed that retrofitting the boiler would not significantly improve the boiler's efficiency. Instead, the Model Program recommends that the town of Sinegorsk replace the boiler with either a conventional fixed or a circulating fluidized bed boiler.

  The Project Team was not able to develop cost estimates for boiler purchase and installation (due to the fact that the Sinegorsk heating system is a district heating system, and the boiler types will have to be developed to specifically fit Sinegorsk) during project implementation. Cost estimates are being developed in cooperation with the Russian Center for Energy Efficiency.

Product(s): 1) Model Program for improving waste management at the mine.

Project Benefits

This project draws on waste management practices which have been implemented successfully for years at mines in the USA. The project built the Project Leader's capacity to improve waste management and disposal at Singorskaya Mine. The Model Plan developed through this project outlines a systematic approach to improving waste management at the mine, which will result in both economic and environmental benefits.

Capacity Building Benefits

This project resulted in several capacity building benefits. First, project activities built the Sinegorskaya Mine management's capacity to approach waste treatment and disposal systematically, addressing the wide spectrum of environmental problems stemming from the mine waste piles. Second, through this project, Sinegorskaya Mine management was introduced to waste management and control practices which have been successfully implemented at mines in the USA for years. Finally, the Project Team shared project recommendations with government officials on Sakhalin Island, introducing them to low-cost solutions to improve waste management in Sakhalin Island mines.

Environmental Benefits

Recommendations in the Model Waste Disposal Program focus on four areas:
(1) sediment/leaching control and capture; (2) coal recovery from waste piles; (3) improved waste treatment; (4) increasing the efficiency of the town boiler. Implementation of each of these measures will result in significant reductions in the environmental impact of mining operations at Sinegorskaya.

- *Installation of Sediment Control Measures.* Project findings estimate that implementation of sediment control measures as recommended in the Model Plan will significantly reduce the amount of sediment flowing into near-by bodies of water. Based on results achieved at US mining operations, it is estimated that implementation of the Model Program will result in reducing the sediment yield to the Susuya River by approximately 90%.

- *Coal Recovery* will reduce the risk and frequency of spontaneous combustion and reduce wind blown dust, leaching contaminants into the ground water and the discharge of sediment to local surface water. Furthermore, recovery of coal in the waste piles would reduce their volume by approximately 1/3, thereby reducing the area of impacted land by about 1/3.

- *Improved Waste-Rock Disposal* will reduce the risk of slope failure of the piles, of spontaneous combustion, and of wind blown dust.

- *The Town Boiler* is currently removing only about 28% of the heat content from the coal. Replacing this boiler with a new system with 75% efficiency will significantly reduce the quantity of coal required to operate the boiler. This will result in an accompanying reduction in emissions of carbon monoxide, carbon dioxide, and particulates. Although a precise estimate of this improvement is a function of the air treatment system and was beyond the scope of this project, it is likely that a reduction in air pollution of 90 to 95% could be achieved with a more efficient boiler.

Economic Benefits

Implementation of two of the above-mentioned recommendations in the Model Waste Disposal Plan will also bring significant financial benefits to the mine and the town of Sinegorsk. Specifically:

- *Coal Recovery* Project findings demonstrate that coal from the existing waste piles can be recovered at about $11.15 per metric ton, or at about one half the cost of mining coal from underground. Coal is currently sold for about $25 per metric ton. Based on processing 100,000 tons of waste rock annually and recovering 32,500 tons of coal from this waste rock, coal recovery from waste piles will result in approximately $450,000 additional income to the mine annually. Depending on the availability of crushing and screening equipment at the mine, the Project Team estimates that purchase and installation of equipment needed to recover coal from the waste piles will cost $680,000 and have a payback period less than 3 years, assuming an interest rate of 12.5%.

- *Boiler Replacement* Results of project findings show that replacing the Singorskaya town boiler with a more efficient system will result in about $260,000 to $340,000 in avoided fuel (coal) purchase costs each year.

Lessons Learned

Lessons learned from this project include the following:

- A significant portion of sediment resulting from mining operations in Russian Far East can be retained on site, without major capital expenditures, using methods that have been successfully implemented in the US for many years.

- Economical methods are available for recovery of coal from waste-rock piles in Russian Far East. Capital costs required for equipment purchases to accomplish this have a payback period of no more than 3 years. Nonetheless, capital money is scarce in Russian Far East, and coal-recovery projects must compete with other priorities for funding.

- Waste-rock disposal practices in Russian Far East create unstable conditions in the waste-rock piles. Practices can be economically implemented to improve the stability of waste-rock piles in the future.

- Replacement of inefficient town boilers in Russian Far East can significantly reduce the quantity of coal required, and the related cost, to produce a given amount of heat.

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